

10/562327  
IAP17 Rec'd PCT/PTO 23 DEC 2005

### **AMENDMENTS TO THE CLAIMS**

The following listing of claims will replace all prior versions, and listings, of claims in the application:

#### **Listing of Claims:**

1. (Original) A control device for generating a desired gait of a legged mobile robot that travels by moving a plurality of legs extended from its body and for controlling an operation of the robot so as to follow the desired gait, comprising:

slippage determining means for determining an occurrence of a slippage of the robot in operation, following the desired gait;

permissible range setting means for variably setting a permissible range of a restriction object amount according to a determination result of the slippage determining means, the restriction object amount being a horizontal component of a translational floor reaction force to be applied to the robot, or a component of the translational floor reaction force in parallel to a floor surface, or a horizontal component of a total center-of-gravity acceleration of the robot, or a component of the total center-of-gravity acceleration in parallel to a floor surface;

provisional motion determining means for determining a provisional motion of the desired gait such that a resultant force of a gravity and an inertial force acting on the robot on a predetermined dynamic model satisfies a predetermined dynamic balance condition; and

provisional motion correcting means for correcting the provisional motion to

determine the motion of a desired gait by changing a changing rate of an angular momentum about the center-of-gravity of a robot from the provisional motion so as to limit the restriction object amount to the permissible range while satisfying the dynamic balance condition at the same time if the restriction object amount determined by the provisional motion of the desired gait deviates from the permissible range.

2. (Original) A control device for generating a desired gait of a legged mobile robot that travels by moving a plurality of legs extended from its body and for controlling an operation of the robot so as to follow the desired gait, comprising:

slippage determining means for determining an occurrence of a slippage of the robot in operation, following the desired gait;

permissible range setting means for variably setting a permissible range of a restriction object amount according to a determination result of the slippage determining means, the restriction object amount being a vertical component of a floor reaction force moment to be applied to the robot or a component of the floor reaction force moment in the direction of a floor surface normal line or a vertical component of a changing rate of angular momentum of the robot, or a component of the changing rate of the angular momentum in the direction of floor surface normal line;

provisional motion determining means for determining a provisional motion of the desired gait such that a resultant force of a gravity and an inertial force acting on the robot on a predetermined dynamic model satisfies a predetermined dynamic balance condition; and

provisional motion correcting means for correcting the provisional motion to determine the motion of a desired gait by changing a changing rate of an angular momentum of the robot from the provisional motion so as to restrict the restriction object amount within the permissible range while satisfying the dynamic balance condition at the same time if the restriction object amount determined by the provisional motion of the desired gait deviates from the permissible range.

3. (Original) A control device of a legged mobile robot adapted to sequentially determine an instantaneous value of a desired motion of a legged mobile robot, which travels by moving legs extended from its body, by using a dynamic model that at least expresses a relationship between a motion of the robot and a floor reaction force, and also to control an operation of the robot at the same time so as to make the robot follow the determined instantaneous value of the desired motion, comprising:

slippage determining means for determining an occurrence of a slippage of the robot in operation, following the desired motion;

permissible range setting means for variably setting a permissible range of a restriction object amount according to a determination result of the slippage determining means, the restriction object amount being at least a horizontal component of a translational floor reaction force to be applied to the robot, or a component of the translational floor reaction force in parallel to a floor surface, or a horizontal component of a total center-of-gravity acceleration of the robot, or a component of the total center-of-gravity acceleration in parallel to a floor surface; and

desired instantaneous value determining means for determining, on the basis of at least the difference between a desired state amount of a posture of the robot that corresponds to the determined instantaneous value of the desired motion and an actual state amount of the posture of the robot, a new instantaneous value of the desired motion such that the restriction object amount determined on the basis of the dynamic model in correspondence to the new instantaneous value falls within the permissible range and the difference approximates zero.

4. (Original) A control device of a legged mobile robot adapted to sequentially determine instantaneous values of a desired motion and a desired floor reaction force of a legged mobile robot, which travels by moving legs extended from its body, by using a dynamic model that expresses at least a relationship between a motion of the robot and a floor reaction force, and also to control an operation of the robot at the same time so as to make the robot follow the determined instantaneous values of the desired motion and the desired floor reaction force, comprising:

slippage determining means for determining an occurrence of a slippage of the robot in operation, following the desired motion and the desired floor reaction force;

permissible range setting means for variably setting a permissible range of a restriction object amount according to a determination result of the slippage determining means, the restriction object amount being at least a horizontal component of a translational floor reaction force to be applied to the robot, or a component of the translational floor reaction force in parallel to a floor surface, or a horizontal component of a total center-of-gravity acceleration of the robot, or a

component of the total center-of-gravity acceleration in parallel to a floor surface;  
and

desired instantaneous value determining means for determining, on the basis of at least the difference between a desired state amount of a posture of the robot that corresponds to the determined instantaneous values of the desired motion and the desired floor reaction force and an actual state amount of the posture of the robot, new instantaneous values of the desired motion and the desired floor reaction force such that the restriction object amount determined on the basis of the dynamic model in correspondence to the new instantaneous value of the desired motion falls within the permissible range and the difference approximates zero.

5. (Currently Amended) The control device of a legged mobile robot according to ~~any one of Claims 1 to 4~~claim 1, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least the ground speed of a distal portion of a leg in contact with the ground.

6. (Currently Amended) The control device of a legged mobile robot according to ~~any one of Claims 1 to 4~~claim 1, wherein the slippage determining means comprises means for determining, on the basis of at least a temporal changing rate of an actual floor reaction force acting on a leg in contact with the ground and the ground speed of a distal portion of the leg, an apparent spring constant of the leg and determines an occurrence of a slippage on the basis of at least the apparent spring constant.

7. (Currently Amended) The control device of a legged mobile robot according to ~~any one of Claims 1 to 4~~claim 1, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least a result obtained by passing an actual floor reaction force acting on a leg in contact with the ground through a band-pass filter having a frequency passing characteristic in a range near a predetermined frequency.

8. (New) The control device of a legged mobile robot according to claim 2, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least the ground speed of a distal portion of a leg in contact with the ground.

9. (New) The control device of a legged mobile robot according to claim 2, wherein the slippage determining means comprises means for determining, on the basis of at least a temporal changing rate of an actual floor reaction force acting on a leg in contact with the ground and the ground speed of a distal portion of the leg, an apparent spring constant of the leg and determines an occurrence of a slippage on the basis of at least the apparent spring constant.

10. (New) The control device of a legged mobile robot according to claim 2, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least a result obtained by passing an actual floor reaction force acting on a leg in contact with the ground through a band-pass filter having a frequency passing characteristic in a range near a predetermined frequency.

11. (New) The control device of a legged mobile robot according to claim 3, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least the ground speed of a distal portion of a leg in contact with the ground.

12. (New) The control device of a legged mobile robot according to claim 3, wherein the slippage determining means comprises means for determining, on the basis of at least a temporal changing rate of an actual floor reaction force acting on a leg in contact with the ground and the ground speed of a distal portion of the leg, an apparent spring constant of the leg and determines an occurrence of a slippage on the basis of at least the apparent spring constant.

13. (New) The control device of a legged mobile robot according to claim 3, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least a result obtained by passing an actual floor reaction force acting on a leg in contact with the ground through a band-pass filter having a frequency passing characteristic in a range near a predetermined frequency.

14. (New) The control device of a legged mobile robot according to claim 4, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least the ground speed of a distal portion of a leg in contact with the ground.

15. (New) The control device of a legged mobile robot according to claim 4,

wherein the slippage determining means comprises means for determining, on the basis of at least a temporal changing rate of an actual floor reaction force acting on a leg in contact with the ground and the ground speed of a distal portion of the leg, an apparent spring constant of the leg and determines an occurrence of a slippage on the basis of at least the apparent spring constant.

16. (New) The control device of a legged mobile robot according to claim 4, wherein the slippage determining means determines an occurrence of a slippage on the basis of at least a result obtained by passing an actual floor reaction force acting on a leg in contact with the ground through a band-pass filter having a frequency passing characteristic in a range near a predetermined frequency.